humidity, researchers are still struggling to pin down conclusive proof of current water flows on Mars. One promising avenue is the observation of recurring slope lineae (RSL) on the edges of certain craters, a seasonal phenomenon that appears to follow warmer conditions, and thus could indicate a thawing and flowing of water just below the surface. In a study due to appear in the journal *Icarus*, Lujendra Ojha and colleagues have detected 13 sites with RSL features after analysing images taken by the current orbiter missions from 200 candidate sites. However, definitive proof that these features are linked to water is still lacking.

Looking at the development of our relationship with Mars from the canali through to the rovers, it is remarkable how science has had to scale down its targets in order to move from romantic imagination to more pragmatic questions. The search for grand civilisations was followed by attempts to detect carbon metabolism, and now we are getting excited about evidence of past habitability — and there is even a study of how this evidence can survive the hard radiation on the surface of Mars.

Rather than giving up after negative results concerning canal builders and carbon consumers, researchers have reframed the quest in the terms of modern astrobiology, which uses life on Earth as a key example for life in the Universe. Taking first steps first, the limits of the life we know must inform the search for habitats, and once they are found, the search for their inhabitants, dead or alive, may follow.

As part of this new era in space exploration, Mars has seen an unprecedented amount of research activity and success in the last two decades. Since the arrival of Mars Pathfinder in July 1997, there has always been at least one probe reporting from the red planet, and at the moment there are five – two rovers and three orbiters – with further missions in preparation.

A side effect of the progress made is that the idea of establishing a human colony on Mars, once the exclusive domain of science fiction, has become the goal of a non-profit company, Mars One (www.mars-one.com). While the cost of sending human explorers to Mars and bringing them back safely is still beyond the scale of what any government or organisation would be prepared to pay for space research, the company reckons that one-way trips could be financed by selling 'reality show' style TV rights to this unique event. The price tag for sending a crew of four to live on Mars has been estimated to be six billion US dollars, while the cost of a return mission might run into hundreds of billions.

The company is already selecting participants from the more than 2,000 applicants. The plan is to launch a demonstration mission and a communications satellite in 2018, a rover in 2020, six cargo missions in 2022, and the first team of settlers in 2024, with further teams following at two-year intervals. Thus, by 2033, all going well, there might be up to 20 human settlers living on Mars.

Apart from the obvious ethical complications, critics have cast doubt on the viability of the business model of the enterprise. *Wired* magazine, not usually averse to futuristic thinking, estimated that the Mars One plan "will most likely struggle to get off the ground" and awarded only two points on a one-to-ten scale of plausibility.

Still, the plans have succeeded in inspiring would-be space travellers and the media alike. Considering the primitive hardware that enabled Neil Armstrong to walk on the moon, there is no reason why today's much more advanced technology shouldn't enable people to live on Mars if they want to and if they can find someone to pay for it. They might even find ways of making the red planet slightly more habitable, for instance by thawing out some of the carbon dioxide in the pole caps.

As we are using up resources faster than Earth can replenish them and survival of our civilisation is by no means assured (Curr. Biol. (2013) *23*, R1017–R1020), expanding onto a second planet may become a logical step for humanity in the near future, as well as an insurance policy against planetary disasters. Maybe, just maybe, there will be canals on Mars one day, and the planet that appears to have been habitable a few billion years ago will become so once again.

Michael Gross is a science writer based at Oxford. He can be contacted via his web page at www.michaelgross.co.uk

Book review

Scientist, socialist: The enduring appeal of Alfred Russel Wallace

Andrew Berry

Alfred Russel Wallace, Explorer, Evolutionist, Public Intellectual — A Thinker for Our Own Times?
Ted Benton
(Siri Scientific Press, 2013)
ISBN: 978-0-957-45302-9

Faced with writing Alfred Russel Wallace's obituary for *Science* in 1913, Theodore Cockerell identified the challenge posed by Wallace: "It is impossible for any man to discuss adequately the life work of Alfred Russel Wallace. His activities covered such a long period, and were so varied, that no one living is in a position to critically appreciate more than a part of them." Wallace is best known for his discovery, with Charles Darwin, of evolution by natural selection, but Cockerell recognized that this was just one chapter in the sprawling Wallace epic. Wallace was still actively publishing when he died in his 91st year — his bibliography runs to over 1000 publications and includes major multi-volume tomes such as *The Geographical Distribution of Animals* — and many of these publications addressed topics far removed from science, including politics, economics, spiritualism, and public health. These were not the fleeting engagements of a dilettante; rather, for Wallace, they were part of a series of long-term crusades into which, to use his own words, he poured "the whole energy of his character". Wallace's output was both prodigious and spectacularly disparate.

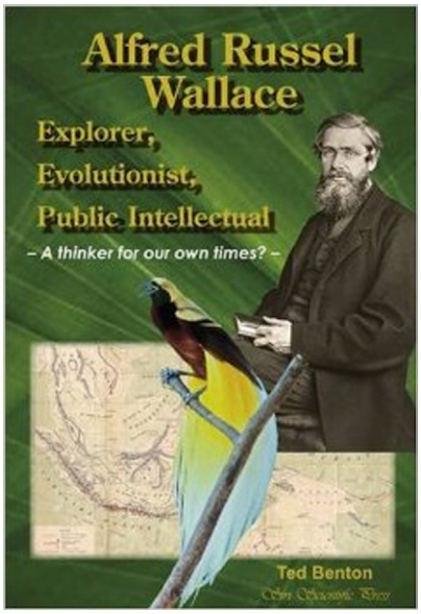
Now, 100 years on, Ted Benton may just be the solution to Cockerell's problem. Benton, the author of *Alfred Russel Wallace, Explorer, Evolutionist, Public Intellectual — A Thinker for Our Own Times?*, is uniquely well positioned to "discuss adequately" Wallace's variegated career. Benton is Professor of Sociology at the University of Essex and is known for bringing a Marxian perspective to the intersection of philosophy, sociology, and ecology. But

he is not solely a social scientist — he is also an accomplished field biologist, having written two books in Britain's fabled *New Naturalist* series, one on bumble bees and one on grasshoppers. Perhaps because he recognizes in Wallace a kindred spirit, Benton's book is in part an appreciation of Wallace, but it is certainly not hagiographic — a mixture of biography, exposition, and analysis, Benton's treatment does not shy away from criticizing its subject.

The first third of the book is devoted to Wallace's biography. This succinct retelling of the familiar story — how, raised middle class but poor, Wallace went on to become a great scientist and prominent public intellectual — is the best short introduction to Wallace I have read. Too often, there is a tendency to focus exclusively on the drama of the early years — the tragic loss of hard-won Amazon specimens in the mid-Atlantic fire, the extraordinary tale of serendipity and gentlemanly improvisation that resulted in the Darwin–Wallace Linnean Society publication. Also, too many scientific accounts see 1862 — the year of Wallace's return from Southeast Asia — as the end of the story, with the remaining 50 years of his life seen as an afterthought or as a sustained unraveling of the scientific reputation that Wallace had established during his 12 years of tropical travel. A contemporary assessment (by George Romanes in 1890) contrasts the 'before' and 'after' Wallaces: "the Wallace of ingenuity and originality" versus "the Wallace of incapacity and absurdity." But Benton does not short-change Wallace's post-Malay Archipelago career, recognizing that much of his best science and virtually all of his non-scientific contributions came after 1862.

The meat of the book, however, is Benton's analysis of three major strands of Wallace's thought: his disagreements with Darwin on sexual selection and on the sufficiency of natural selection to account for human evolution, and his embrace of socialism. I particularly enjoyed Benton's account of the Darwin–Wallace dispute over sexual selection. Wallace was never comfortable with the idea that animals might be capable of making aesthetic judgements (as in choice in intersexual selection), and insisted that the sexual dimorphism that Darwin attributed to sexual selection should be explained in terms of natural selection. The reason female birds are often drab relative to males is that they are under natural selection for crypsis because they have to sit on the nest to incubate their eggs. Wallace's explanation for male gaudiness was less convincing — he argued that bright colours were a default reflection of underlying physiological 'excitability' — but, as Benton points out, there was more to Wallace's critique of sexual selection than this. He presaged today's 'good genes' arguments in sexual selection in his recognition that a reproductive choice might be "effective because it improves the ability of the selecting sex to detect quality in the selected sex." Whereas Darwin proposed that sexual selection could promote the evolution of functionless traits whose value was solely aesthetic, Wallace insisted that selected characters had to be functional — that is, in current terminology, they had to be honest indicators of fitness. For Wallace, then, those aspects of sexual selection he deemed workable were merely forms of natural selection. With reference to this single-minded devotion to the idea that natural selection is the sole driver of evolution, Wallace once wrote that he was "more Darwinian than Darwin."

Benton asserts that it was in part this fixed focus on natural selection that accounted for the *big* split between Darwin and Wallace. In 1869, Wallace published his claim that natural selection was insufficient to account for human evolution, concluding that some teleological supernatural force must therefore have been involved. Darwin was deeply disturbed that Wallace had defected on this, an issue so sensitive that he had carefully sidestepped it in *The Origin*: "I hope you have not murdered too completely your own & my child." There are many factors at play in Wallace's rejection of materialistic explanation here but most interesting is his argument that the human brain is in effect over-engineered: "In his large and well-developed brain he possesses an organ quite disproportionate to his actual requirements — an organ that seems prepared in advance, only to be fully utilized as he progresses in civilization." Natural selection, Wallace appreciated, was not prescient, but responded only to immediate, here-and-now needs. Benton suggests that Wallace's exclusively natural-selection perspective is a major part



of the problem here. "So, Darwin, too, conceded that the agency of natural selection was not sufficient to account for the origin of many distinctive human traits — as well as gender and racial differences. But Darwin's response to this was to complement natural selection with a series of other hypothetical mechanisms [including, among others, sexual selection]." Wallace's only-natural-selection rigidity caused him problems: if natural selection could not readily account for human traits, then he was left with no option but to invoke non-material alternatives.

In seeking connections between Wallace's scientific and his political thought, Benton again brings sexual selection to the fore as he moves on in the book's later chapters to Wallace's economics and politics. Wallace's preoccupation with social justice is already apparent in some of his very earliest writings, and the theme dominates his final book, *The Revolt of Democracy.*

> During the whole of the nineteenth century there was a continuous advance in the application of scientific discovery to the arts, and especially in the invention and application of labour-saving machinery; and our wealth has increased to an equally marvellous extent. Various estimates which have been made of the increase in our wealth-producing power show that, roughly speaking, the use of mechanical power has increased

> more than a hundredfold during the century; yet the result has been to create a limited upper class, living in unexampled luxury, while about one-fourth of our whole population exists in a state of fluctuating penury, often sinking below what has been termed "the margin of poverty." Of these, many thousands are annually drawn into the gulf of absolute destitution, dying either from direct starvation, or from diseases produced by their employment, and rendered fatal by want of the necessaries and comforts of a healthy existence.

Wallace, however, was not merely a hand-wringing commentator. He also offered solutions, which ranged from hard-nosed, practical to airy-fairy, utopian. In the former class were his suggestions surrounding land nationalization — he perceived "landlordism", to use Wallace's preferred term, to be one of the major causes of inequality and injustice. Benton reviews the various (and evolving) suggestions Wallace put forward to eliminate private ownership of land. The airy-fairy aspects of Wallace's political thought are a marriage of solid progressive ideas and a frankly mystical insistence on the guiding power of natural selection in the future production of ever more moral people. This is where Wallace brought sexual selection into play. In an era when universal suffrage was still a contentious issue, Wallace was unequivocally in favour of women getting the vote — "All the human inhabitants of any one country should have equal rights and liberties before the law; women are human beings; therefore they should have votes as well as men" — and saw the emancipation of women as critical to the future well-being of humans. Sexual selection, he claimed, would be key. And this, note, would be Wallace-style sexual selection, based on preferences for fitness-related traits, not Darwin-style sexual selection, in which useless, arbitrary aesthetic traits are preferred. The emancipated woman would, for the first time in human history, have the freedom to choose a partner who "has proved himself to be worthy of respect by the place he holds and character he bears among his fellow labourers in the public service."

Wallace scholars disagree on the consistency — or lack of it — of Wallace's worldview. For example, was his stance on human evolution in part a response to his conversion to spiritualism in 1865 or was it a reflection of deeper convictions about human exceptionalism formed much earlier in his life? Benton, rightly in my opinion, is happy to see Wallace as intellectually labile, even though he roots Wallace's social thought in a set of encounters at Mechanics' Institutes and the like as a very young man. Indeed, Benton highlights the tension between apparently contradictory strands of thought: "The fascination of Wallace's thought is, for me, the persistent *struggle* to make coherent sense of the enormously wide first-hand experiences and intellectual scholarship." Returning from Indonesia, for example, Wallace lauds the Dutch colonial administration as a model of paternalistic imperialism: "There is in many respects an identity of relation, between master and pupil or parent and child on the one hand, and an uncivilized race and its civilized rulers on the other." But in his later writings, he is staunchly anti-imperialistic, insisting on "the rights of every people to govern themselves," and surely cringed when he went back to read his earlier words.

Given Benton's interest in how Wallace dealt with the conflicts in his own thinking, it is disappointing that he has chosen to avoid a major strand of Wallace's thought, spiritualism. Wallace attended his first séance in 1865 and was soon publishing on what he deemed to be a legitimate area of scientific enquiry. Spiritualism remained a central passion for the rest of his life. The teleology that first appeared in his thinking on human evolution would, later in life, become a dominant feature of Wallace's worldview, as would his mystical belief in an ever-better future for humanity. As Wallace biographer Martin Fichman has argued, we have to view Wallace's thought holistically: his worldview was not a series of independent, compartmentalized perspectives, but, rather, a complex, messy whole. Benton writes that this exclusion is because Wallace's spiritualism has "less contemporary relevance" but my sense is that there after all is a hint of hagiography at play here. Benton admires Wallace's science and his socialism, but cannot bring himself to fully engage with the Wallace of spiritualist "incapacity and absurdity".

Another disappointment is that a book as important as this has not received the editorial care and attention it deserves. Put out by a tiny press, Siri Scientific Publications, its cover art screams 'homemade' and this impression is not diminished by the quality of the production within. The claim, for example, that an Indonesian mountain (p. 47) is "over ten thousand metres high" cannot be explained away as a typo.

As the world currently gears up to celebrate the centenary of the start of World War I, it is impossible not to be struck by the contrast between the bright-eyed utopian vision of a better world that Wallace clung to and the brutal reality that settled over Europe just a few months after Wallace's death. But, as Benton points out in his final chapter, elements of Wallace's vision remain relevant, even pressing. Take, for example, Wallace's extraordinarily prescient environmentalism:

> The struggle for wealth, and its deplorable results… have been accompanied by a reckless destruction of the stored-up products of nature, which is even more deplorable because more irretrievable. Not only have forest-growths of many hundreds of years been cleared away, often with disastrous consequences, but the whole of the mineral treasures of the earth's surface, the slow products of long-past eons of time and geological change, have been and are still being exhausted (1898)

Wallace's mix of science and politics is quirky and sometimes dated, but reading Wallace (and Benton) is an invitation to respond to the question in Benton's subtitle, "A thinker for our own times?" with a resounding "Yes". Wallace's reputation has been resurrected with the surge over the past decade in Wallace scholarship and with the recent centennial celebrations, but Benton takes this resurrection much further. Benton's Wallace is not just an admirable past figure unfairly sidelined by history; rather, he is the prototypical socially engaged scientist with a message that remains today alarmingly relevant.

Department of Organismic and Evolutionary Biology, Harvard University, 16 Divinity Avenue, Cambridge, MA 02138, USA.
E-mail: Berry@oeb.harvard.edu